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ABSTRACT

The booklet discusses research on characteristics and remediation approaches for children with learning disabilities (LD). Initial sections consider definitions, prevalence and causes of LD, while a fourth chapter reviews such LD characteristics as attention disorders, visual-perceptual difficulties, and memory disorders. Also considered are academic skill deficits in reading, expressive language, and arithmetic. Medicine-related treatments (including sensory integrative therapy and diet) are described along with such education-related treatments as perceptual motor training, applied behavior analysis, and diagnostic-prescriptive teaching. (CL)

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What Research Says to the Teacher

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Learning Disabilities

by Donald H. Johnson
and Leah J. Johnson

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INTRODUCTION

For just a minute, recall someone in your elementary or secondary school classes who had a learning disability. If that proves difficult, try to recall someone who failed or had great difficulty with schoolwork. While it is relatively easy to identify and describe the results of learning failure or learning difficulty, it is extremely difficult to identify and describe the underlying causes of that failure, particularly since the causes appear to lie within the individual.

After nearly two decades of attention to the topic of learning disabilities (LD), relatively little is known. Most proposed definitions or descriptions of learning disabilities are unacceptable to either parents, educators, or other professionals for a variety of educational, legal, political, and/or economic reasons. Furthermore, research on learning disabilities is compromised by the vast heterogenity of LD populations.

In spite of significant obstacles to a better understanding of learning disabilities, we have witnessed an increased sensitivity to individual differences in learning. Experts now look beyond cultural, environmental, and motivational differences to focus on patterns of intellectual organization and on specific abilities brought to the learning task. Many children presently labeled as learning disabled probably would, in past years, have been termed mentally retarded or emotionally disturbed. While the label LD carries its own concomitant omens and misconceptions, it offers more hope and less stigma to those with serious learning difficulties not attributable to obvious physical or emotional causes.

As the following research summaries are presented, the reader must bear in mind several important considerations. First, the term learning disabilities means many things to many people. Some equate LD with minimal brain dysfunction (MBD) or with hyperactive behavior, while others relate the term to specific behaviors such as uncoordination, reversals in reading, and/or mirror images in writing. Therefore, any research population may be very different from another and its constituent members may be more different than alike. It follows, then, that one must be careful not to generalize from the results of studies with mixed groups. Second, a great deal of the research on LD and MBD is conducted in medical institutions using clinical patients. Third, many studies have weak designs with inadequate controls, brief treatment periods, and no reports of replication. Despite these shortcomings, existing research studies do provide some guidelines for teachers. These guidelines are presented throughout this report.

Teachers must bear in mind that not all children with learning difficulties can or should be described as having a learning disability. Most children experience great difficulty with school-related tasks at one time or another during their educational career. The terms disability or disabled should be used sparingly and only in a context that will bring enlightened attention to the needs of this special group of learners.

DEFINITION OF A LEARNING DISABILITY

Since the federal government and most state governments have now recognized learning disabilities as a handicapping condition and have allocated funds for the education of children with learning disabilities, the federal definition has assumed increasing importance and is presented as background to our report of research. This definition was approved in December 1977:

> Specific learning disability means a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, which may manifest itself in an imperfect ability to listen, think, speak, read, write, spell, or to do mathematical calculations. The term includes such conditions as perceptual handicaps, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia. The term does not include children who have learning problems which are primarily the result of visual, hearing, or motor handicaps, of mental retardation, of emotional disturbance, or of environmental, cultural, or economic disadvantage. (42)*

This definition is further operationalized as (1) a severe discrepancy between achievement and intellectual ability in one or more of the following areas:

(a) oral expression
(b) listening comprehension
(c) written expression
(d) basic reading skills
(e) reading comprehension
(f) mathematics calculations
(g) mathematics reasoning

and (2) achievement not commensurate with children's age and ability level in the above when provided with learning experiences appropriate for their age and ability levels. (42) With these broad requirements, one must be careful not assume that an individual labeled learning disabled has any one specific academic deficit, or any special characteristic, or any particular pattern of characteristics.

PREVALENCE AND CAUSES

The prevalence of learning disabilities in the population is related to how one defines learning disabilities. Most estimates range from 3 to 15 percent. (79, 110) If one uses a very narrow definition, such as

*Numbers in parentheses appearing in the text refer to the selected references beginning on page 27.

neurological impairment, an incidence of 1 to 3 percent is probable. (114) If a serious discrepancy in academic achievement, such as two or more years below grade level, is part of the definition, a 15 percent prevalence rate is likely. (106, 110, 113) If one surveys a kindergarten class looking for characteristics ascribed to the learning disabled child, the prevalence figure may go as high as 41 percent. (130) Most experts in the field of LD place the prevalence rate at 5 percent or less. (159, 79, 151)

There are few cross-cultural studies of learning disabilities. Tarnopol (144), in a study of worldwide reading and learning problems, found estimates of reading disabilities that ranged from 1 percent in China to 33 percent in Venezuela, with a median of 8 percent. The prevalence of reading disabilities, at least, seems to be lowest in the Oriental countries where both ideographic and phonetic languages are learned.

From four to eight times as many boys as girls evidence learning disabilities. The estimated ratio worldwide for reading problems is approximately 3 to 1. (144)

Learning disabilities and socioeconomic status are moderately correlated in many studies. However, this relationship usually can be attributed to intelligence or IQ. (118) When intelligence is controlled, socioeconomic status does not seem to be a factor.

The probable causes of LD are almost infinite. Therefore it makes little sense for the teacher to be concerned with causal relationships within such a broadly defined class of behaviors. The literature is replete with speculated causes such as minimal brain dysfunction, cerebral palsy, cortical blindness or deafness, epilepsy, oculomotor deficits, inadequate memory or thinking, disorders of attention, dysarthria, birth defects, poor teaching, emotional disturbance, vestibular disorders, visual-perceptual problems, auditory-perceptual problems, neurological impairment, developmental lag, sensory integration problems, hyperactivity, and uncoordination. The attempt to establish a direct causal relationship for specific disabilities is a complicated and elusive task. Therefore, we will focus on what is known about the characteristics of children with LD and let readers infer causal relationships where they are so inclined.

CHARACTERISTICS OF CHILDREN WITH LEARNING DISABILITIES

The most common characteristic of children with learning disabilities is, by definition, underachievement. The subject areas most often involved are reading, spelling, and arithmetic. Writing is absent from this list probably due to a lack of standardized assessment procedures in writing. Research on LD in these specific academic skill areas will be presented following a summary of research on other characteristics of children with learning disabilities.

Disorders of Attention

Children with learning disabilities frequently are described as having a short attention span, poor concentration, and/or faulty attention. (24, 38, 83, 145) In recent years attentional deficits have become one of the more promising areas of research, as witnessed by the large number of articles in professional journals.

Dykman et al. (38) have suggested a specific LD syndrome with a cardinal symptom of defection attention. They found that children with a learning disability frequently have difficulty coming to attention due to extraneous and possibly disruptive motor activity and/or because it is difficult for them to select and organize the salient features and critical attributes of a task. Geschwind (500) has suggested that defective arousal structures, or defective coupling of arousal and other perceptual and motor structures could explain the increased autonomic reactivity, the longer reaction times, and more important behaviorally, the short attention spans and poor concentration of some children with LD. Most available research evidence suggests that these disorders of attention are age-related and represent a developmental lag rather than a more permanent defect in learning ability. (38, 59)

The research on distractibility is somewhat confusing and deserves further explanation. Children with LD have been found to be more distracted by lights and noises than were controls. (145) Yet children with LD have performed as normals in a task-specific situation when deliberately distracted by flashing lights. One feasible explanation is that children with LD perform adequately when the relevant stimuli are easily distinguishable from the irrelevant but have great difficulty when they are of equal intensity.

Children with LD often have problems with decision-making. In some cases where the child appears unable to reach a speedy decision, impulse control seems to be a factor. (145) Impulsivity has been observed as an important characteristic of LD children (24, 145), especially in severely disordered children. (82) Other qualities that make it difficult for LD children to make decisions are lack of effective perceptual and cognitive strategies for problem solving and an inability to maintain attention and vigilance. (38, 83)

Hyperactivity

Estimates of hyperactivity in children with learning disabilities range from 23 to 50 percent. (38, 106) In the general schoolage population, 3 to 20 percent exhibit hyperactive behavior. (156) The prevalance rates in the general population are similar to the estimates for both LD and MBD, although clearly these are different behavioral syndromes. The sex ratio of hyperactive children varies from 4:1 to 10:1 in favor of boys. (29, 70, 116, 144) This does not, however, imply anything about sex-linked

inheritance. (116) Apparently there are vast cultural differences in individual behavior, or in the tolerance of individual behavior, as surveys in England report only a 0.1 percent incidence of hyperactivity in the schoolage population. (125)

Children described as hyperactive vary greatly both in the cluster of symptoms they present and in the related problems they encounter. A most perplexing question for the teacher is, "Where do you draw the line between normal and abnormal behavior?" At one age or another most children are active, have short attention spans, display tantrums, lie, cheat, and/or exhibit other disruptive behavior.

Several studies of temperament (142) suggest that high activity level, intense emotional reactivity, and distractibility emerge as a cohesive pattern of behavior early in life and are relatively stable throughout childhood. Distractibility, aggression, and emotional immaturity seem to linger along with poor academic functioning. Weiss (155) found 80 percent of the children initially diagnosed as hyperactive were academic underachievers five years later. Disorders of attention and concentration remained, but restlessness was expressed in less disturbing ways as they matured. A small minority of hyperactive children, 20 percent, continued to show serious antisocial behavior. Recent evidence (155) suggests the prognosis is better when hyperactive children leave school, since the work environment provides a more benign setting for the overactive adult.

Hypoactivity

A small group of LD children exhibit underactive rather than overactive behavior. These hypoactive children are a less studied group because they demand less attention and are less likely to be referred to a clinic. Dykman (38) found that approximately 23 percent of his clinical children diagnosed as MBD were hypoactive. In the general population the prevalence rate would be significantly lower.

Sensory, Perceptual, and Perceptual-Motor Impairments

For many years, perceptual problems were thought to be probable causes of learning disabilities. But perceptual processes were not differentiated, and the term perception covered a range of central processing functions from sensation to higher-order thinking. Processes such as auditory, figure ground, and visual-motor integration were reified and operationalized into major developmental and remedial programs. An analysis of research on sensory, perceptual, and perceptual-motor impairments is presented below.

Vision and Learning Disabilities

Several studies report that children with LD have a higher incidence of certain specific ocular defects in spite of being found "normal" in routine vision or sight tests. (2, 146) Oculomotor deficits are not thought to be the cause of reading impairment, but rather, visual information processing is reflected in the pattern of oculomotor activity. Thus, oculomotor deficits may reflect a dysfunction in central transmission processing. (91) For example, measures of saccadic (rapid, flickering) eye movements during reading consistently indicate that poor readers have saccades of shorter duration and higher velocity (91) and that they make more fixations and more regressions than do good readers. (2, 56, 146) It appears that saccades of short duration and high velocity do not allow enough time for effective transmission, leading to segmentation, inability to achieve fluency, transposition, and the skipping of words, sentences, or paragraphs. Reversals and other orientational errors may result either from a deficit in orientational selectivity or from insufficient stimulation or overstimulation of visual cortical cells. (91)

In response to much concern about vision and LD, several leading medical associations (47) issued a joint statement in 1972 which said, in essence: (1) children with LD have the same incidence of ocular abnormality (e.g., refractive errors and muscular imbalance) as normal achievers in reading; (2) no peripheral eye defect produces dyslexia and associated LD; (3) there is no evidence that either visual training (e.g., muscle exercising) or neurologic organization training (e.g., laterality, balance board, or perceptual training) is warranted; (4) excluding correctable ocular defects, glasses have no value in the treatment of dyslexia; and (5) the treatment of dyslexia in learning disabled children is essentially a problem of educational science. These conclusions, however, have been refuted by optometrists involved with LD. (47)

Visual-Perceptual Difficulties

Visual-perceptual difficulties were implicated in much of the early research on learning disabilities. The high level of interest in visual perception was undoubtedly due to the moderately high correlations of tests such as the Developmental Test of Visual Perception (DTVP) with a variety of criterion measures such as classroom adjustment, motor coordination, and intellectual functioning. (49) As a result of interest in these processes, major training programs such as the Frostig-Horne and Winterhaven were implemented on a district-wide basis to prevent reading failure. The massive correlational research that followed was reviewed in several studies. (66, 90) It was concluded that neither the total score nor the subtest scores of the DTVP relate meaningfully to reading, while all but the score in Eye-Hand Coordination were useful predictors of arithmetic achievement.

The moderate relationship of visual-perceptual ability to reading success can be viewed from either of two directions: either that good reading is a function of good visual-perceptual skills, or that as children learn to read, they develop adequate visual-perceptual organization while learning to scan and to control their eyes in a coordinated fashion. (81)

Auditory-Perceptual Difficulties

Hearing problems have seldom been associated with LD, and research on auditory-perceptual difficulties has produced conflicting results. Sabatino (132) reviewed research on the relationship of auditory-perceptual skills to reading and concluded that a relationship between reading failure and auditory functioning is well established. There are numerous articles that show poor readers tend to be poor auditory perceivers. However, careful inspection of published literature concerned with the relationship between various auditory skills and reading achievement reveals that the findings in this area are replete with contradictions. (98) Hammill and Larsen (64) examined a large number of studies relating reading to measures of auditory discrimination, memory, blending, and auditory-visual integration, and concluded that auditory-perceptual skills are not sufficiently related to reading to be particularly useful for school practice.

Perceptual-Motor Difficulties

Many of the early researchers in LD focused on perceptual-motor development. They placed great emphasis on early motor learning and the child's visual-spatial development. (32, 49, 51, 84) The tools and techniques of these researchers ranged from balance beams to swimming pools, and they frequently developed intricate training programs involving both parents and children. Despite the effort expended, researchers have been unable to establish a positive relationship to academic achievement.

In summary, one must be careful not to consider perception an organismic entity such as language, motor ability, or physical growth. Perception is not a predefined entity; it is an abstract category with only the meaning one ascribes to it. (150)

Disorders of Memory

With the exception of studies of short term memory (STM), investigations of memory disorders in LD children have been very limited. STM deficits have been reported by a number of researchers (100, 109), but this research is complicated by the tendency to operationalize STM as the score on a digit-span test. Digit span is more accurately a repetition task

than a short term memory task. The measurement of memory functions also is confounded by the complexity of the memory process and the researcher's dependence on receptive and expressive responses. Memory difficulties may occur in any one of three processes: (1) registration or reception (STM), (2) retention or storage (long term memory), and (3) recall or retrieval. It has been observed that children with LD do not make use of the various ways of organizing memory. (126) Therefore, they may need to be taught overt strategies and "tricks" often developed by good learners. (60)

Disorders of Thinking

Research is scarce on higher-order thinking processes in LD children. Concept formation is considered to be one of the most important aspects of learning and one of the ascribed deficit areas for LD children. (77) Yet, in at least one study, children with LD have been found to be just as cognitively efficient as normals *when untimed*, a finding that seems consistent with the research on attention span and decision-making in children with learning disabilities. (38) Another researcher found evidence that the decision and/or thought processes in LD children are lengthier, whether they perform a task correctly or incorrectly. (102) Children with LD generally should be provided with additional time, but time alone will not resolve difficulties in planning and organization.

Mixed Dominance

Mixed and/or incomplete dominance have been associated with reading and learning problems since Orton's classical statement on the relevance of cerebral dominance to language and learning disabilities in children. (117) Some of the early studies found a high incidence of crossed dominance, mixed dominance, and incomplete dominance, leaving the researchers to conclude that eye and hand dominance were significant causes of reading problems. (10) As additional research was analyzed it became clear that both mixed dominance and poor reading may in fact be due to a similar cause, such as minimal brain dysfunction or neurological impairment. (9, 78)

The statistics indicate that about 33 percent of the population at large has mixed dominance, 98 percent are right-handed, but only 66 percent are right-eyed. (55) In the general population, hand differentiation begins in the child at about nine months and is virtually completed by two years of age. (78) It has been found that almost all right-handed people and about two-thirds of left-handed people have a language-dominant left cerebral hemisphere. (104) A number of studies (58, 78) have found no support for the hypothesis that learning disabilities are related to incomplete or crossed- hand or eye dominance. Goldberg (55), in a study

of 100 achieving students, suggested there would be no statistically significant difference between the dominance of those who are achieving poorly and those who are successful.

Emotional Concomitants

There is limited direct evidence on the social-emotional difficulties of children with LD. Generally, these children are moderately well adjusted, yet they can experience serious problems. Two probable reasons are (1) academic failure, mediated by lower self-confidence, and (2) difficulty in comprehending visually and aurally presented communications. (28) It has been observed that many children with LD lack various social skills; therefore they do not relate easily to their peers and have problems forming social relationships. Research has shown that learning disabled children are deficient in their ability to empathize. They are more egocentric and less competent than peers in perceiving the affective states of others. (5)

Connolly (28) suggested that the less accurate understanding of nonverbal communication may affect both the attitudes of others toward LD children and the behavioral interactions that discriminate LD children from normals. In a replicated investigation of the peer popularity of LD children, Bryan (18, 19) found that LD children received significantly more votes on a scale of social rejection and fewer votes on a scale of social attraction than other children.

ACADEMIC SKILL DEFICITS

Reading

Most children with learning disabilities have reading problems. (86) But within the LD population there are wide-ranging differences in both the severity of reading difficulties and the relationship of reading to other problems. (77)

Reading disorders of LD children are most likely due to neurological impairments or delayed development. These disorders should be differentiated from those problems due to external interferences or lack of correspondence between the task to be learned and the child's experiences, language, or dialect. (157) The mismatch of instruction and learning is an area of special concern to those attempting to alleviate the reading problems of disadvantaged children.

The term dyslexia is typically applied to those severe reading disorders that appear to have a neurological cause. (33, 77, 111, 152) Estimates of severe disorders range from about 2 to 15 percent of the schoolage population. (77, 113) Dyslexia is usually found in combination with other impairments and probably can be divided into subtypes based upon the

extent of auditory and visual strengths or weaknesses. (77)

Research on reading disorders underscores the relationship of language to reading. Children with learning disabilities frequently exhibit oral language problems most likely related to delays in specific aspects of cognition or a reduction in the retrieval of verbal labels and syntactic structures. (158)

Recent research has tended to focus on cognitive processes and language development rather than on perception. Children who appear to have perceptual deficits may not be having difficulty discriminating, perceiving, or sequencing individual items on a page, but may be experiencing difficulty in conceptualizing, associating, and comprehending the *relationships* between the individual items. (62, 69, 101, 109, 152, 153) Even at a very basic level, reading disabilities appear to involve cognitive rather than perceptual processes (151). A reader must make correct associations between graphemes and phonemes in order to account for subtle and critical differences in the structure of a letter or word. Children unable to acquire the skill of phoneme-grapheme correspondence lack stable verbal mediational devices that can alert them to the differences in sound/symbol configurations. As a group, LD children are markedly deficient in their ability to hold together grammatical structures and to abstract meaning from the larger context. (77, 152)

Expressive Language

LD children with reading difficulties are almost certain to have expressive problems, since many of the same information processing skills come into play. Written expression is the highest, most complete form of communication and the last to be learned. Learning to write is a thinking process involving the integration of visual, motor, memory, and other cognitive processes. (76)

Handwriting requires automatized visual and motor skills. The LD child usually lacks rhythm, omits letters, inverts or transposes letters, and is generally characterized as irregular in the mechanics of reproducing written words. (71) A severe deficit in this skill is called dysgraphia and may be caused by inadequate visual perception, poor visual-motor coordination, unsatisfactory motor control, emotional instability, or faulty instruction. (76) Left-handed children have a special problem because they tend to write from right to left and have difficulty seeing what has been written because their hand covers the graphic symbols. (92)

Spelling is a very demanding task for LD children since it requires encoding a word without the aid of visual cues. (3, 67) The child must have adequate visual memory to integrate with auditory cues in order to reproduce the correct formation and sequence of letters. English spelling patterns are highly irregular since there is no one-to-one correspondence

between the spoken sounds and written letters. (122) However, research has shown that in spite of the irregularities, there are predictable linguistic structures that can provide a system of phonological and morphological regularity. (67, 92) Bryant (21) suggests that spelling is frequently a more sensitive indicator of language disabilities than reading, because there are fewer and less effective methods to compensate for spelling problems.

Arithmetic

The arithmetic problems of children with learning disabilities are less studied than other language processes. It is quite rare for a child to have difficulty with language and not experience difficulty with arithmetic, even though there are isolated cases where arithmetic performance far exceeds other language performance. (25) Most children with arithmetic disabilities also experience reading problems.

Children with learning disabilities generally score far below their age group on computational skills. Recent research has investigated the extent to which this difficulty with computation extends to other mathematical processes. One consistent finding is that LD children do not differ from other children on Piagetian-type tasks such as conservation when IQ is controlled. (46) This is noteworthy in that Piagetian tasks measure conceptual thought rather than rote learning and memory.

Since difficulties with auditory memory and sequencing are characteristic of children with arithmetic disabilities (112), one must consider the decreased ability of LD children to receive and process verbal instructions given aloud by a teacher. Difficulty with sequencing could also be symptomatic of disturbances in organization, making it imperative for the teacher to give instructions deliberately and offer extra help to LD children in planning and organization.

TREATMENT AND/OR REMEDIATION

The identification of a disability raises many questions. Can the disability be remediated? Will the individual overcome the disability regardless of treatment? Should one more appropriately learn to compensate for the disability? Do all people need the same skills anyway?

Remediation often conveys to the child a sense of being different or inferior. In the majority of children with significant difficulties in learning, remediation must be recognized for what it is, a practice necessitated by a system in which the limits of normality have been narrowly drawn. The solution to many of the problems discussed in this report may rest on a willingness to expand the range of learner

characteristics viewed as normal, and to adapt instructional programs to accommodate that range.

Medical-Related Treatments

Drugs

Learning disabilities per se are not an indicator for drug usage, but pharmacologic treatments for deficits in attention and for severe hyperactivity have become popular. While the actual number of schoolchildren in the United States receiving psychotropic medication is unknown, it is often reported to be alarmingly high. (48) The best data available, however, indicate that only from one to two percent of elementary schoolchildren are receiving drugs for hyperactivity, and most are taking stimulants, particularly Ritalin. (88) These same studies indicate that about 33 percent of identified hyperactive children are receiving medication.

Psychostimulants such as dextroamphetamine (Dexadrine) and methylphenidate (Ritalin) do not improve a learning disability but rather make the child more available for learning. The general theory is that the ascending reticular activating system in these children is immature or dysfunctional. Thus the sensory-filtering processes are not effective, resulting in distractibility and short attention span. Their motor-inhibiting processes are also ineffective. The psychostimulants "strengthen" the ascending reticular activating system, thus improving the sensory-filtering and motor-inhibiting processes. (136)

Short-term studies of the use of Dexadrine and Ritalin have consistently reported success in improving children's ability to concentrate on schoolwork and improve their attention to tasks that do not normally engage their full interest. (142) There is limited long-term research data, but one five-year study using a criterion of social adjustment reported no differential effect for stimulants, tranquilizers, or no drug treatment. One must therefore withhold judgment on long-term effects of drug treatment until more evidence is available. About two-thirds of all hyperactive children respond to stimulant drugs. (115) Effectiveness usually decreases at adolescence, and there is no evidence that children treated for prolonged periods later become addicts. (48) Side effects such as loss of appetite or insomnia typically occur only with overdosage.

Nutrition and Diet

Nutrition operates at all levels of biochemical and metabolic functions to create an optimum molecular environment for the brain. (31, 120) Researchers have noted how deprivation of certain chemicals early in life

causes many illnesses, including mental retardation. Recent research also suggests that improper nutrition contributes to cerebral dysfunction (134) and central nervous system anomalies. (147) Therefore, it is not surprising that a number of researchers and writers have advocated special nutrition treatment plans for children with learning disabilities. The two popular plans are megavitamin therapy and special diet.

Megavitamin therapy is advocated by Cott (31) and Pauling. (120) Generally the therapy requires massive doses of specific vitamins. Cott's daily treatment, for example, consists of one to two grams of niacin, one to two grams of ascorbic acid, 200 to 400 milligrams of pyridoxine, and 400 to 600 milligrams of calcium pantothenate. (31) Pauling defines orthomolecular medicine as the treatment of mental disorders by the provision of optimum molecular environment for the mind, especially the optimum concentration of substances normally present in the human body. The general consensus at this time is that there is no objective evidence supporting megavitamin treatment of LD children. (135, 136)

The most popular advocate of diet treatment has been Benjamin Feingold, developer of the Kaiser-Permanente (K-P) Diet. (43) According to his theory, all foods containing additives, dyes, or natural salicylates are to be excluded from the diet of the hyperactive, learning-disabled child. While Feingold claims dramatic results, there is little evidence to support his claims. Double-blind studies are needed in order to sort out effects due to the diet itself.

Vision Training

As reported earlier, there appears to be a genuine difference of opinion between opthalmologists and optometrists on the value of vision training. It should also be noted that vision training is typically conducted by optometrists and not by opthalmologists. While there is clinical evidence to show improved reading with oculomotor training (146), most research is contaminated by visual-perceptual, sensory-motor, and even gross motor training. Keogh (81) reviewed a large number of studies of vision training and concluded that confusion within the available literature makes cross-study comparisons difficult.

Neurophysiological Retraining

One of the early remedies for learning disabilities was offered by Doman and Delacato at the Institutes for Achievement of Human Potential. (35) Their underlying philosophy is that individual human development repeats the pattern of human evolutionary development. Failure to pass through a certain sequence of developmental stages in mobility, language, and competence in the manual, visual, auditory, and
16 tactile areas reflects poor neurological organization. Therefore,

neurophysiological training is a way to recover normal development by a wide variety of sensory-motor activities. While no definitive study of this treatment has been made, several medical, professional, and parental associations have published statements expressing concern about the effectiveness of this form of therapy. (136)

Sensory Integrative Therapy

Ayres (4) postulated that children's learning deficits reflect inadequate sensory integration in the brain stem. This is suggested by immature postural reactions, poor extra oculomotor muscle control, poorly developed visual orientation to environmental space, difficulty in the processing of sound into impressions, and the tendency toward distractibility. Her sensory integrative therapy provided carefully controlled stimulation through the vestibular (balancing) and somatosensory (positional awareness) systems in order to improve the brain stem's integration of signals coming from eyes and ears. There is no convincing evidence to date that the mastery of such postural skills carries over into academic skills such as reading. (136)

Education-Related Treatments

Perceptual-Motor Training

There are many excellent reviews of perceptual training, and generally the same conclusions are reached. Myers and Hammill reviewed 31 studies of the Frostig-Horne program and found that 68 percent of the results were negative. Only the slightest gains were made in academic and cognitive-language skills. Thirteen percent of the studies reported academic growth, none reported development of cognitive-language skills, and 40 percent reported some visual-motor development. Results obtained from studies using visual-motor and gross motor programs were similar. (109) Thus the evidence suggests that training usually results in some improvement in visual-motor skills, but that a corresponding increase in academic skills will probably not occur.

Hammill and Bartel concluded that the usefulness of perceptual-motor training has not been sufficiently demonstrated to warrant the expenditure of the school's funds or the teacher's time. Teachers should implement perceptual-motor training on a remedial basis only in those few cases where improvement in perception is the goal, and such efforts should be considered experimental. (62)

Visual-Perceptual Training

Reviews of more than 60 studies and over 700 coefficients depicting

the relationship of tests of visual perception to tests of reading, arithmetic, and spelling suggest that the relationship is not significant enough to be of use to teachers. (26, 90)

Auditory-Perceptual Skills

Research on the effectiveness of auditory-perceptual training is inconclusive. (132) Questions remain as to what training methods, if any, are effective. Sabatino and Hayden (133) found that perceptual training was most beneficial in the early primary grades, since children use their language skills to compensate for perceptual difficulties as they advance in age. Hammill and Larsen (64), as reported earlier, concluded from their review of the research that auditory skills are not sufficiently related to reading to be particularly useful for school practice. But they caution that this conclusion does not generalize to other auditory functions such as auditory acuity, listening comprehension, or phonics skills.

Psycholinguistic Training

Opinion is mixed on the usefulness of psycholinguistic training based upon the Illinois Test of Psycholinguistic Abilities (ITPA) constructs. Lund (97) reviewed 38 studies and concluded that some studies show significantly positive results, some studies show positive results in areas remediated, and some studies show results from which any conclusion can be drawn. Hammill and Larsen (63, 65) reviewed research studies which attempted to stimulate psycholinguistic constructs as measured by the ITPA; they concluded that psycholinguistic training is essentially nonvalidated.

Improving Attention and Memory

There are suggestions that both attention and memory problems can be mediated through the use of language. (61, 105) That is, language can be used to help the child direct his attention. Impulsive children, for example, have been taught to talk themselves through problem-solving situations. (105)

Can children improve their memories? The span of memory doesn't seem to increase with maturity (126), but there have been some successful techniques reported for increasing the number of items recalled. Children can be taught to (1) look for common attributes, (2) pay attention to at least the important attributes on simple tasks, (3) use language to help their memory by naming things and putting them into meaningful phrases, (4) use mental imagery by being encouraged to think of things in vivid pictures, and (5) use mnemonics wherever practical.

In working with LD children it is important to recognize their

limitations in attention and memory by considering (1) the length and complexity of the sentences used in instruction, (2) the number of different instructions given, (3) the introduction of as many memory strategies as possible, and (4) avoidance of nonessential memory loads. Write instructions on the chalkboard, tape a list to the desk, post it on a chart. (126)

Diagnostic-Prescriptive Teaching

Following the medical model, numerous researchers and writers have advocated a diagnostic-prescriptive approach to the education of children with learning disabilities. This approach uses psychoeducational assessment followed by prescriptive or remedial teaching tailored to the child's diagnosed strengths and weaknesses. At one level, the diagnostic work is done by psychologists or other nonteaching personnel who then forward recommendations (prescriptions) to the instructional staff. At another level, the teacher assumes full responsibility for both diagnostic and prescriptive activities within the classroom setting. In both approaches there is an assumption of demonstrable aptitude-treatment interaction (ATI).

While the diagnostic-prescriptive approach is favored among special education teachers, especially those concerned with learning disabilities, there is little empirical evidence to support the validity of the concept. (160) At present, then, there is little support for claims that instruction can be differentiated on the basis of diagnosed strengths and weaknesses, a finding that no doubt contradicts the experience of many skilled teachers. One must, however, consider the methodological problems of test validity and research design before accepting the above findings as conclusive.

Applied Behavior Analysis

An alternative to diagnostic-prescriptive methodology is applied behavior analysis (ABA). Lovitt (94, 95) suggested that the apparent rationale for defining pupils as learning disabled is to group the children for subsequent instruction. This thinking is based on the belief that if learning disabled children can be grouped together, a common treatment can be administered to them. It is implied that once a LD treatment is administered, the children will no longer be disabled. The fallacy of such logic is clearly evident in the fact that there is no functional definition of learning disabilities leading to a uniform treatment. (94, 95)

The characteristics of applied behavior analysis are direct measurement, daily measurement, replicable teaching procedures, individual analysis, and experimental control. (94, 95) Results of studies using ABA typically report favorable results in support of the methodology.

Unfortunately, it is difficult to generalize from any one set of findings because the treatment calls for the application of specific techniques to specific situations.

One particularly noteworthy finding of research in ABA with LD children is that children with learning disabilities show significant decreases in performance under conditions of partial reinforcement. Inconsistent reinforcement appears to produce highly undesirable personality traits and/or behavioral response styles in these children. (119)

Remediation in Specific Academic Skills

Reading

Research has shown that children with learning disabilities can become productive citizens and moderately successful readers. Studies have shown that dyslexic children learn to compensate for their reading disability and become successful physicians, lawyers, and businessmen. (33) What then can the teacher of learning disabled children do to provide an appropriate learning environment for these children?

It has been suggested that old habits, attitudes, and teaching techniques be radically altered in work with LD children. (6, 8, 93) Once these students experience a reading disability, they often avoid or withdraw from activities requiring reading. As a result the deficit intensifies, and the need to reverse that behavior must become a primary goal of the teacher. (85, 92)

Research has shown that behavior modification (13, 68, 92, 96, 154) and the use of high-interest materials are successful tools in motivating LD children to alter their reading behavior. (6, 44, 54, 80, 139) Severe reading disability is not corrected by short intensive treatments, and it has been suggested that reading disabilities are probably a chronic illness in need of a long-term treatment. (7, 41) The following one-to-one reading experiences have been successful with LD children: parent and child reading together (107, 124), the Neurological Impress method (73, 88) in which the teacher and child read in unison, and the use of individual tutors or para-professionals working on specific skills. (103, 143) The strength of the one-to-one learning technique lies in the increased attention to the child, immediate feedback on performance, modeling of fluent reading behavior, and the necessity for the child to attend to the task of reading. (23, 93) McInnis (103) suggests that to be effective, remediation in reading must be conducted on a one-to-one basis.

The child's language experiences have formed the basis of many programs designed to teach severely retarded readers to become proficient readers. (6, 44, 80, 139) It cannot be overemphasized that writing is a most valuable tool in teaching reading. (6, 33, 99) Teaching reading and writing simultaneously rather than as separate subjects enhances three important processes of language comprehension: (1)

visual perception of the letters forming words and sentences, (2) auditory perception of the sounds of words, and (3) tactile perception derived from writing words. The child discovers grapheme-phoneme relationships and at the same time learns spelling patterns and sentence structure. (33)

In contrast to other strategies used in remediation, the language-experience approach does not use a structured word-attack system. Instead, the child is taught to develop word-attack skills through experience activities with words. (44, 99) This method has been used successfully with LD children who often find it difficult to analyze the phonemic structure of a word from speech to print. The difficulties are compounded by the inconsistencies of the English language. (122)

Recent developments in reading research have supported the concept of teaching phonemes through experiences with language. Researchers reason that children have already learned to generalize about the sound elements in oral language and should be able to use the same internal processes to generalize about the sound elements in written language. It is important to recognize that children learn about spoken language by integrating visual, auditory, and other sensory information within their environment without the intervention of adults. (22, 138, 152, 153) Therefore, it follows that these same integrated processes can be used to teach the child how to read.

In support of the approach outlined above, a number of guidelines are presented for use in the remediation of reading problems: (20, 23, 138, 149)

1. Focus on the most basic perceptual association that will help the child establish sound/symbol relationships through the use of whole words rather than individual letters. Linguistic programs are available to provide a sequence for this instruction. (123, 127, 131)
2. Perceptual and associational responses should be overlearned until they are automatic. The task should be simple enough so that recognition becomes quick and automatic. Tracing, writing, flashcards, language master, and tachistoscopic devices are some of the techniques that can be used for drill until an automatic response is established in the child's memory.
3. Plan learning experiences that the child can perform successfully. Discourage the laborious sounding out of words lest reading become an impossible task of pausing to identify every word, rather than a group of words that combine to give meaning.
4. Construct reading experiences that use skills the child has learned previously in order to develop new skills in a context that is challenging, interesting, and exciting.

Reading comprehension is a process of inquiry. (140) Children need to be taught to read as a means of developing cognitive and thinking skills. As children read, they gather data, make predictions, pose problems, ask questions, and seek solutions to these questions. The teacher must guide

children to (1) raise questions, (2) build hypotheses, (3) read and process data, and (4) test findings to determine validity. Comprehension is the cornerstone of reading and is integrated within many reading programs. The Neurological Impress method (73), which uses simultaneous reading by child and teacher, is a useful technique for developing comprehension skills in LD children.

Phonics programs that teach isolated word-analysis skills have been used extensively with learning disabled children. (40, 52, 139) There are three widely used phonics-based programs:

The Gillingham-Stillman method (52) systematically introduces phoneme/grapheme associations through heavy vocalization by the teacher and child. Reading is delayed until the phonics program has been learned.

Distar (40) focuses on the decoding task. A teacher-training course accompanies the program so the teacher understands the materials being used, as well as how to program for instruction. Reading is taught through sounding out isolated words using a modified system of print before traditional written expression is introduced. The child learns to analyze words before beginning work on comprehension.

The Writing Road to Reading (139) is a unified phonics method that teaches phonograms through auditory, visual, and kinesthetic functions. Spelling is the basic key to this program, and the rules of spelling are memorized. Reading begins after the child has learned enough sight words to understand a sentence.

The phonics approach to reading has been researched, and programs have been found successful for certain groups of children in particular situations. (57) Yet there is insufficient evidence to prove that success in phonics-based programs leads to later success in reading and comprehension skills. (72, 75, 133)

A recent study suggested a carefully sequenced program, based on sound learning and transfer theory, that conforms to the developmental states of a child, is an appropriate method for timing instruction. McInnis (102) developed and tested a structured program that integrates published materials and specific techniques that have been proven successful. This sequence of instruction includes: (1) sound/symbol relationships from the *Recipe for Reading* (148), (2) *Auditory/Motor Program* from the *Perceptual Skills Curriculum* (128), (3) *Glass-Analysis for Decoding Only* to teach word attack and spelling (53), (4) Neurological Impress (73), and (5) Cloze technique for comprehension and directed recall. (15)

While there are conflicting views on the most effective approach in remedial reading, a few guidelines seem appropriate. First, any approach to reading should be carefully planned, structured, and applied consistently. Second, the teacher's responsibility is to provide the raw material for reading, to serve as a model for fluent reading, and to provide students with opportunities for plenty of practice with successful reading experiences.

Expressive Skills

The most effective ways to teach spelling and writing to learning disabled children are the integrated reading/language programs suggested above. Specific spelling strategies to use with LD children have been outlined in the work done by Arena (3), Consilia (30), and others. (67, 92, 121, 129) The limited research on remediation of writing difficulties in LD children suggests that their difficulties are not due solely to problems with the mechanics of writing but may also involve inadequate assignments or lack of time to complete a task. (11) Dawson (34) has designed a developmental sequence for a language-experience approach to writing that can be a useful tool in the hands of teachers who teach learning disabled children.

Arithmetic

Research is very sparse on remediation in arithmetic for LD children. While some early investigators regarded arithmetic achievement as simply a product of drill (77), later findings (25) suggest that the same deficits that create difficulty in other language areas cause difficulties with arithmetic and mathematical functions. Neither simple drill nor the use of manipulatives will alone solve the mathematical problems of the child with a learning disability, yet these methods can be a part of the remedial program. Other suggestions are: (1) provide additional orientation and explicit instructions on the part of the teacher, (2) provide children with learning "tricks or crutches," (3) have the children orally summarize the instructions or the concept, and (4) use specific applications of the concept or process. (141) Children with learning disabilities should be encouraged to use calculators and technical aids where available. (1) Reinforcement strategies have proved effective in increasing speed of performance in children with learning disabilities but do not enhance the acquisition of a new concept. (137)

PLACEMENT OF CHILDREN WITH LEARNING DISABILITIES

There is considerable evidence that special class placement for children with special needs has limited value and, in fact, may be detrimental to the development of adequate life adjustment skills. A number of mainstreaming alternatives have been implemented for LD children, but research evidence in support of mainstreaming is not yet available. The most popular plan for children with learning disabilities seems to be regular class placement with resource room assistance. For children with severe learning problems and compounding emotional

overlays, special class placement in combination with mainstream activities is becoming the dominant mode. The ultimate answer to the placement question is most likely related to situational factors such as local attitudes, facilities, support, and relevant characteristics of the individual learner. (36, 107, 161)

Public Law 94-142 directly affects students with learning disabilities. We suggest you consult the following NEA publication for specific information in this area: *Education for All Handicapped Children: Consensus, Conflict and Challenge*.

SUMMARY

In summary, the research suggests that children with learning disabilities are more different than alike. This overriding heterogenity of LD children makes it extremely difficult to conduct definitive research. There is no single cause of a learning disability, but rather many causes. Research that attempts to establish causal relationships generally yields conflicting and confusing results. Children with learning disabilities manifest a wide variety of debilitating characteristics, including attentional deficits and memory problems. Current research efforts seem to be focused more on cognitive than on perceptual processes.

Nearly all children with true learning disabilities have reading deficits. In most cases these deficits are probably due to minimal brain dysfunction or delayed maturation. Reading skills must be viewed from the perspective of total language development. Children with language problems will in all likelihood have arithmetic problems as well.

Remediation or treatment of children with learning disabilities raises serious professional concerns. Stimulant drugs have proved relatively effective in the management of hyperactive behavior, but we must continue to search for alternatives. Nutritional treatments are popular, but their effectiveness is not established. Most attempts to improve academic achievement through central processing training have failed. Perceptual training may be useful in certain individual situations but usually does not improve reading. Even the diagnostic-prescriptive approach espoused by so many has yet to be proven effective. Applied behavior analysis can be viewed as a promising development.

Reading remediation has had a great deal of recent attention but has been only moderately successful. A number of techniques have been effective, from highly structured phonics programs to language-based programs.

We offer the following suggestions based on our analysis of the research and on our own professional experience. First, structure is very important for children with learning disabilities. Plan carefully and sequence whenever possible. Second, whatever you do, do it consis-

tently. Achievement is, to a great extent, related to consistency. Third, you must believe in what you are doing and be enthusiastic about it. Experience has shown that you can make it work if you really believe in it.

NEUROSCIENCES AND BRAIN RESEARCH

In the previous pages, we have presented research findings that have immediate implications for the education of children with learning disabilities. Yet there is another level of research being conducted by basic science and medical personnel that should ultimately offer assistance to teachers. With recent advances in neuroanatomy and neurophysiology, and motivated by an elevated public interest, a large number of neurologists and neuropsychologists have turned their attention to developmental learning problems. Many children with learning problems are now referred for a neurological examination and, as expected, many show classical soft neurological signs such as left-right disorientation, awkwardness, and short attention span.

Research suggests some major differences in the functioning of the dominant (usually the left) and nondominant hemispheres. Cognitive functions such as the structuring of language, calculation, and other logical operations are located in specific areas of the left hemisphere while less structured functions such as sensory discrimination, recognition of patterns, and spatial relationships are associated with right-hemisphere functioning. Some have observed that schools are primarily left brain-oriented, and that the right brain is generally underutilized. There may be some credence to this argument, but it is simplistic to think that one can train or educate one side of the brain without affecting the other.

The human brain is a marvelously complex organ not readily available for research. Therefore, one must be careful to distinguish between what is known and what is speculated about brain functioning. Much of our knowledge of how the brain works is based upon observations in the rat, cat, and occasionally the monkey. Until very recently our knowledge about human brain functioning came solely from studies of damaged brains, observations of clinical patients, and from lobotomies performed in mental institutions. Many scientists are now studying brain functioning by the use of evoked potentials, that is, by measuring the amount and location of an electrical effect produced by a specified stimulus. The basic electroencephalogram (EEG) is being extended to include auditory, visual, and somatosensory evoked potentials.

Persons interested in the neurosciences and brain research should consider some of the supplementary references included at the end of the Selected References.

GLOSSARY

APHASIA—impairment of the ability to use or understand oral language. It is usually associated with an injury or abnormality of the speech centers of the brain.

CEREBRAL DOMINANCE—the control of activities by the brain, with one hemisphere usually considered consistently dominant over the other.

CLOZE TECHNIQUE—consists of a passage with certain words omitted. The student supplies the missing words. The primary purpose of this technique is to teach comprehension.

DYSCALCULIA—lack of ability to perform mathematical functions, usually associated with neurological dysfunction or brain damage.

DYSLEXIA—a disorder of children who, despite conventional classroom experience, fail to attain the skills of reading. The term usually is used when neurological dysfunction is suspected as the cause of the reading disability.

GRAPHEME—a written language symbol that represents an oral language code.

LATERALITY—involves the awareness of the two sides of one's body and the ability to identify them correctly as left or right.

MINIMAL BRAIN DYSFUNCTION—a mild or minimal neurological abnormality that causes learning difficulties in the child with near-average intelligence.

MIXED DOMINANCE—tendency to perform some acts with a right-side preference and others with a left, or the shifting from right to left for certain activities.

PHONEME—the smallest unit of sound in any particular language.

SACCADES—eye movements, actually little jumps, with intervening fixation pauses. Saccades are thought to be related to information processing.

SYNDROME—a characteristic grouping, or pattern, of symptoms that usually occur in a particular disability.

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